TECHNOLOGICAL DEVELOPMENTS IN INFORMATION PROCESSING AND THE RESULTANT IMPACT ON USER ORGANIZATIONS.

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THESIS

Technological Developments
in
Information Processing
and
the Resultant Impact on User Organizations

by

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September 1977

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Technological Developments in Information Processing and The Resultant Impact on User Organizations

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ABSTRACT

This thesis has a basic hypothesis that previous failures of information systems in organizations are directly related to the disproportionately high amount of emphasis given to the technical aspects of data processing as compared to the inadequate attention and concern devoted by management, computer specialists, and users of information systems to critical behavioral issues. The behavioral issues presented are subunit conflicts, training, skills, and perceptions of the participants, information sharing, power, and organizational politics. After reviewing the underlying reasons behind the lack of success achieved in the past, the organizational impact of fourth generation distributive processing techniques is predicted. A conflict and power model is presented that addresses the key organizational variables that prohibit successful information systems' design and development. Recommendations regarding operation, design, and organizational activities are presented with the goal of improving ultimate user satisfaction of data processing services.

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I. INTRODUCTION

Large-scale computing systems have revolutionized the management of most means by which goods and services are produced, or information is accumulated. Such systems interact with organizational, historical, and political pressures to shape the internal structure of industrial, governmental and other organizations. They also shape the way in which organizations interact with individuals.

During active proliferation of new and revised management procedures, designers of information systems cannot help being organizational designers as well. They cannot avoid changing organizations. But which way will the changes go? It has been pointed out long ago that intelligent understanding of a machine mode of control may be delayed until long after this control has been exercised [Weiner, 1954]. Thus, there exists widespread concern about the ultimate effect of information systems on the quality of life of their end users.

Current research has indicated that users do not understand much of the output they receive, there is duplication of input and output, and changes are frequently made in systems without consulting users. Because of inaccuracies, users often discount all of the information provided by a system. Many users complain of information overload; massive amounts of data are provided which cannot be digested by the decisionmaker. There are also many complaints about

the difficulty of obtaining changes in existing systems. A number of users report that they do not actually use the information provided by an information system [Lucas, 1975]. Many feel that computer-based information systems are not worth the time or cost to develop, and that the organization would be better off without them.

One major design problem which has been often overlooked is how information is used by a decisionmaker. Systems have been designed to provide data without considering the types of use of the information. As the information systems technology continues to mature, more sophisticated systems will be designed and implemented and the need for understanding the uses of information and the resultant impact on organizational behavioral patterns will become more critical.

In addition to understanding user needs and the use of information, there are three major problem areas in systems design and implementation. The first is technical and includes designing a system, writing programs, testing the systems, and converting the old files and procedures into a new system. The second problem category is organizational: new work relationships are established, changes are made in job content, and the structure of the organization affected. Organizational problems include user cooperation in design, resistance to change, and modifications in the distribution of power among organizational subunits. The third and final systems-design problem area is project management. Management must coordinate users, the computer staff, and possibly

consultants, and must manage the development of a system. This management task has proven to be very difficult and the attainment of the original design goals elusive [Brooks, 1974]. The major attention in improving information systems has been on the technical problem areas. However, recently interest has been stimulated in some of the managerial and behavioral difficulties of developing systems by Kay, 1969, and Jones and McLean, 1970.

A. OBJECTIVE

This study focuses on broad management and organizational relationships, and therefore deliberately avoids, to the maximum extent possible, the more technical aspects of computers and computer utilization.

The major thesis is that the reasons information systems fail are that too much attention has been paid to the technical aspects of data processing, and that too little attention has been given to organizational behavior problems in the design and operation of computer-based information systems.

This study, accordingly, was motivated not only by an interest in computer impacts but also by a conviction that managerial action, especially at the top, strongly influences the way that computer technology develops and that, in turn, computer use changes the manager's world in certain predictable ways. The changes in the manager's world are changes affecting him, his colleagues, and his subordinates, individually and jointly.

The objectives of this thesis are:

1. To demonstrate the types of changes in organizational structure, job content, communication patterns, and the nature of control in organizations that result from the introduction of computer technology into the modern firm.

2. To show that when an organization is considering new data processing application it must understand and carefully match the stage of growth for the corporate function involved with that of the data processing technology it intends to introduce into the firm.

3. To describe some of the underlying psychological and social issues that can result in organizational conflict between the information system's staff and the users of data processing services.

4. To propose recommendations that will:

a. minimize the adverse behavioral effects that result from computer technology introduction.

b. resolve some of the intrinsic conflicts that information systems introduction tend to highlight.

B. SCOPE

The primary focus of this thesis is on the organizational impact of the computer. The reason for such a focus is simple: organizations are where computers are located. It is in these organizations that the initial confrontation occurs between man and his invention.

A cursory review of the computer industry is presented along with a description of how the uses of computers have changed in the last thirty years.

An estimate of future information systems is described in terms of distributive systems and the way in which behavioral patterns may be modified.

Managers are responsible for organizational effectiveness--for deciding, for example, whether to use computers and how to use them. They are also responsible for deciding what organizational changes are essential when the computer is adopted, and for accomplishing the necessary changes. This document explores the backgrounds, attitudes, and perceptions of the two major participants in the computer introduction process, namely, the computer specialist and the manager.

Special attention is devoted to the basic nature of organizational information requirements, the time value of information, the use of information, and the problems of the resistance that is established by organizational members and subunits to information sharing.

A detailed set of recommendations is presented that should allow for the participants in the organizational subunits to more effectively prepare for, design, and implement new data processing systems.

II. COMPUTER INDUSTRY - A USER PERSPECTIVE

The relatively brief history of computers has followed, for the most part, the cycle of all high technology industries: a rapid buildup of the technology with the resultant lag in the ability of the users to see the true implications of the device or to tap its full potential. This "cultural lag," as it has been termed, has certainly been true in the computer industry. Viewing the 50's as the first decade of computer usage, the sixties as the second, and the seventies as the third, certain generalizations can be formulated regarding the evolutionary development from a user's standpoint.

A. ERA OF THE ENGINEER

The fifties was the era of the engineer. The need for the first computers was created by engineers, mathematicians, and scientists in their demand for raw calculating power. At first, there was no great interest in the use of computers for business purposes. Early computers were supported by government and educational funds; cost effectiveness was not the primary focus. The first computers were big "number crunchers," expensive, and difficult to maintain and use. Since much of the work given to computers had not been done before, it was hard to determine whether computer benefits offset costs. Cost justification is particularly difficult in experimental research and development. The machine builders received little help from equipment users. Business

was not yet aware of the computer's vast potential in business operations. There were no company planning or special interest groups to give substantive guidance or direction to the computer manufacturer. Frequently a product was developed before its market potential had been determined. Thus, the already developed product sought a suitable market instead of being determined by market place needs.

B. MARKETING PERIOD

As the first computer decade was the era of the engineer, the second decade was that of the marketeer. These marketeers were young, ambitious, enthusiastic, intelligent, and wrapped up in their new product. As a result, they oversold it on a grand scale. They failed to realize the practical company environment in which computers had to operate, and they vastly overestimated their customer's capability to use the equipment. However, the marketing forces did their job; the sixties marked the era of computer proliferation with the number of installed computers increasing from 4000 to 50,000 systems. [Kanter, 1973] has described the plight of the user and upper management in the sixties in these terms:

> Computer users have to share the blame for the large increase in computer installations. Very few understood the role the computer should play in a company; they didn't select the areas where it should be used; they didn't establish priorities or determine schedules; and future systems planning was almost nil.
>
> Upper management didn't understand the computer's true nature and didn't take the time to learn, either because they didn't think they could, or because they thought it was merely another accounting tool that belonged in the

> controller's shop. So they turned over the computer to the technocrats. Thus, systems and programming priesthoods ran the show and managed the new machines.

During this decade, the advanced system or innovative approach was the standard approach. The value of something became a function of its uniqueness or complexity, not its worth to the user; the means justified the ends. Vendors and users alike were subject to a "wish-fulfillment syndrome," so that when a new technique or product appeared which bore some relationship (albeit remote) to a user problem, there was a tendency to apply it, regardless of its relevance. The computer and the various concepts of management information systems, central data bases, operations research, and management science were facets of this "wish-fulfillment syndrome" of the sixties. These activities of the sixties have caused many of the lingering negative perceptions of data processing that still exist in the late seventies.

C. ECONOMIC REALITY

The third computer decade began with the business turndown of 1970-1971. Companies found themselves under-utilizing their computers or with excess capacity, because of the oversell and overbuy trend of the late sixties at a time when their business volume was down. For the first time since the computers appeared on the commercial scene, data processing managers were forced to cut computer operating budgets.

This economic reality of a downturn has caused a return to solid business practice and tighter control over computer and related expenditures. Data processing departments are

beginning to be scrutinized as closely as other operating departments within a company, while the computers themselves are treated as major capital expenditures which come under stringent analysis regarding return on investment and cash flow. There is a more formal planning process by both the vendor and the customer. This planning cycle emanates more from user needs and requirements rather than from technology and product considerations. Users dictate the "what" of EDP while vendors supply the "how." The key justification criteria are becoming "ease of use" and "total user benefit" instead of the degree of sophistication.

III. COMPUTER TECHNOLOGICAL GROWTH AND ITS CHARACTERISTICS

A. SYSTEMS ARCHITECTURE

Improvements in performance have typically occurred in a cyclic fashion where each cycle has become known as a "computer generation." The 'life cycle' within a computer generation tends to proceed as follows: a new component technology is moved from the laboratory to production machines, often within an order-of-magnitude increase in performance over the previous component technology (generation). Component characteristics, circuit designs, and manufacturing techniques continue to be improved and refined to produce further improvements in performance, reliability, power consumption, cost, and other characteristics. Subsequently, the diminishing returns on component improvement focus attention on innovations in computer architecture and software techniques which promise greater performance improvements.

Theoretical studies are undertaken to invent system architectures which, although not practical with the current generation hardware, provide for large improvement in performance with future generations component technology. Indeed, it is characteristic of each computer generation that architectural concepts conceived during earlier generations, but not economically feasible at that time, became practical with the new component technology.

Since "Computer Generation" is not a precisely defined concept, there are some differences in opinion about how

many generations there have been to date, and about what the criterion for a new generation is. In fact, it has been suggested that there are really two generation scales: component generations and computer generations; the latter includes architectural and software-oriented features. Each computer is thus characterized by a two-component generation vector.

The following characterizations of component generations are generally accepted [Joseph, 1972]:

Generation 0. Relays and vacuum tubes. Used to build one-of-a-kind computers, such as Harvard-IBM computers, ENIAC. Time period up to 1953.

Generation 1. Vacuum tubes. Commercial computers, such as UNIVAC I, IBM 701, IBM 704, IBM 709; 1951-1958.

Generation 2. Transistors. The beginning of solid-state component technologies. Examples are Philco 2000, IBM 7090, CDC 6600, and the supercomputers STRETCH (IBM 7030) and UNIVAC's LARC; 1958-1969.

Generation 3. Solid-state integrated circuits (ICs). An example is the IBM 360 series, Burroughs 6500, and UNIVAC 1108; 1967 to date.

Generation 4. Solid-state medium-scale integration (MSI) and large-scale integration (LSI). Here entire subsystems are manufactured as one monolithic unit. Examples are the ILLIAC IV computer and the developmental NAVY AADC (All Application Digital Computer).

Computer generations have been characterized by [Joseph, 1972] as follows:

Generation 1. Special-purpose computers; introduced in 1951-1952 for scientific or business computations; single job operation; about 100 simple instructions, a few index registers; machine language, subroutines, utility routines, symbolic assemblers.

Generation 2. General-purpose computers; introduced in 1958-1960 for general data processing, about 100 complex instructions, independent and simultaneously

operating I/O, high-speed main memory, and a mass memory; batch processing type of operation; higher-level languages, software monitors, macro-assemblers, executives.

Generation 3. Computer systems, families of computers; introduced in 1963-1965 for general information processing, multiprogrammed and time-shared operation, remote terminal interactive and job-entry systems; multiprocessing and real-time teleprocessing systems; operating systems, many higher-level languages, modular programs, reentrant subroutines, conversational systems.

Generation 4. Networks of computer systems; introduced in 1970-1972 for on-line information processing; multiprocessing, new architectures, direct higher-order language processing; mini- and micro-computers; extendible languages, meta-compilers, subprograms in hardware, microprogrammable computers.

[Joseph, 1972] has also studied the development of computer generations and the associated improvements in performance and physical characteristics. He makes the following observations:

- Δ Each new component generation has come along after an interval of six years.
- Δ On the average, each new component generation has resulted in the following changes in computer characteristics:
    - o Speed increased 10 times
    - o Memory capacity increased 200 times
    - o Reliability increased 10 times
    - o Component cost reduced 10 times
    - o System cost reduced 2.5 times.

B. STAGES OF GROWTH

Although the system architecture analysis discussed in paragraph A. above provides a clear historical perspective on the development of the computer hardware industry, it does not adequately address the growth of the organizational functions and the interaction and/or impact that the

concomitant growth of data processing has made in the process.

"S" is the shape of growth. The "S" curve can be used to apply to the origin and growth of anything. It reflects the outcome of the underlying structural conflicts and balance from the conception to the maturity of any phenomenon. It can be found to represent histories of societies (as expounded by Spengler to Toynbee), success patterns of organizations, market penetration patterns of products, as well as life cycles of technologies. Though much effort is expended in describing the conditions that prevail during various phases of growth, the really worthwhile insights come from an examination of those elements that would allow for the explanation of the delicate relationships that drive the growth process and make it ultimately obsolete.

The spokesmen most articulate about the cyclical growth patterns in data processing are [Gibson and Nolan, 1974]. Perhaps the best summary of their analysis is that the data processing budgets for a number of companies, when plotted over time from initial investment to mature operations, form an S-shaped curve. Based on this insight, they proceeded to segment the growth history into four stages, namely, initiation, expansion, formalization, and maturity. For instance, it appears that many organizations have developed a pattern for growing computer applications as they move into more advanced stages of development. Similarly, increased personnel specialization can be found in organizations as they

progress from functional simplicity to more complex forms of division of labor. Most importantly, a shift in management focus, control methodology, and presumably the successful leadership personality type changes as costs escalate and the role of data processing matures. Figure 1 below is a synopsis presentation of the work of Gibson and Nolan and describes the changes in applications, management, and personnel as data processing matures.

[Withington, 1974] starts with the same objective as other "stage" theorists. He points out that:

> .....few executives have a clear picture of each of the generations of computerization and of the ways in which these succeed each other.

However, if the stage theory is applied,

> such an overview.....permits rational long-range planning; management can plan for each generation with a clear idea of the goals it ought to be able to achieve.....and how to prepare for the transition (change) to the next generation.

Withington's view of the evolutionary process is that it is essentially technology driven (see Figure 2) and that rapid reductions in technology costs have the decisive impact on variables such as: new application functions brought into the data processing fold; and organizational structure for managing the data processing environment with the resultant effect it has on the organizational structure. The major portion of the current literature supports Withington's reasoning process of treating technology as the dominant enabling factor that paces the rate at which computers enter the life of an economy. Many organizations are now entering

APPLICATIONS

STAGE I	STAGE II	STAGE III	STAGE IV
Cost Reduction-Accounting	Proliferation in All Functions	Emphasis on Control	Data Base Applications
Payroll	Cash	Project Control	Simulations
Receivables	Ledger	Scheduling	Planning
Payables	Budgets	Cost Analysis	On-Line Inquiry
Billing	Inventory	Chargeouts	On-Line Order Entry
	Personnel		
	Orders		
	Sales		
	Production		

MANAGEMENT

STAGE I	STAGE II	STAGE III	STAGE IV
Lax Management	Promotional Management	Control Manangement	Resources Management
In Accounting	In Finance	Independent Function	Independent Unit
	Systems Analysis	Steering Committee	Systems & Programming Decentralized
Control Lacking	Lax Control		Chargeouts
	Few Standards	Standards	Services Pricing
	Informal Project Control	Project Control	Design Controls
		Chargeouts; Audits; Operate Controls	
Loose Budgets	Loose Budgets	Strong Budgets	Long-Range Planning

PERSONNEL

STAGE I	STAGE II	STAGE III	STAGE IV
General Specialization	Applications Specialization	Control Specialization	Data Base Specialization
Operator	Systems Programmer	Development Programmer	Data Base Programmer
Programmer	Scientific Programmer	Maintenance Programmer	Teleprocessing Programmer
Analyst	Business Programmer	Functional Analyst	Data Base Manager

Figure 1. The Gibson and Nolan Four Stages of Growth

Stage	New hardware	New software	New functions	Organizational location	Effect on organization
I	Vacuum tubes, magnetic records	None	Initial experimental batch applications	Controller's department	First appearance of technicians (with salary, responsibility, and behavior problems); automation fears among employees
II	Transistors, magnetic cores	Compilers, input/output control systems	Full range of applications, inquiry systems	Proliferation in operating departments	EDP group proliferation, some workers and supervisors alienated or displaced; introduction of new rigidity out; also new opportunities
III	Large-scale integrated circuits, interactive terminals	Multifunction operating systems, communications controllers	Network data collection, remote batch processing	Consolidation into centrally controlled regional or corporate centers with remote terminals	Centralization of EDP organization; division data visible to central management; some division managers alienated.
IV	Very large file stores, satellite computers	General-purpose data manipulators; virtual machines	Integration of files; operational dispatching, full transaction processing	Versatile satellites instead of terminals, with control still centralized	Redistribution of management functions, with logistic decisions moving to headquarters and tactical decisions moving out; resulting reorganization; field personnel pleased
V	Magnetic bubble and/or laser-holographic technology, distributed systems	Interactive languages, convenient simulators	Private information and simulation systems, intercompany linkages	Systems capabilities projected to all parts of organization; networds of different organizations interconnected	Semiautomatic operating decisions, plans initiated by many individuals, leading toward flickering authority and management by concensus; greater involvement of people at all levels; central EDP group shrinkage.

Figure 2. Withington's Five Stages of Growth

Gibson and Nolan's Stage IV or Withington's Stage V and are experiencing the related organizational dilemmas that result in the transitioning process.

IV. DRIVING FUNCTIONS CAUSING THE CHANGE

A. INDUSTRY DEMANDS

Although measured in billions of dollars, data processing is a small part of the total economy. However, the United States economy is becoming increasingly service oriented in terms of both employment and contributions to the Gross National Product. It is estimated that office expenditures will range between $450 and $475 billion dollars in 1977. Traditional data processing will account for a mere $30 to $32 billion of this total. Yet if there is little prospect for "traditional" data processing, there is a great deal of room for growth in the "information systems" industry. For example, each office employee is currently supported by some $6,000 to $7,000 in capital equipment, whereas each factory employee is supported by $25,000 to $30,000 in equipment. Opportunities for productivity improvements in the office and in business communications abound, and a host of companies are entering this market. In a recent survey conducted by Gnostic Concepts "Fortune's 1000" companies, some 63% of the respondents were found to be favorably disposed to the trend of distributed information processing, while only 26% were firmly opposed. The results also show that order entry and fulfillment applications are receiving the most attention, becoming a focal point for integrating communications with data and text processing. Organizational

integration of office, communications, and data processing services is currently taking place to support such applications.

B. ORGANIZATIONAL REQUIREMENTS

A corporation is an organization with a common purpose in which a number of human beings share and to which they contribute their personal service or their capital, expecting some return. Organization theorists have come to a more complex view of the corporation, in which it is seen as a combination of "systems"--an authority/responsibility system, a reward/penalty system, a communication system, a social system, and others. These systems are obviously interrelated. A corporation must determine how the computer can facilitate the operation of its other "systems" in the overall corporate purpose. Its management must therefore continuously distinguish between what is potential in the computer and what is actual with respect to its capacity to forward the corporation's overall purposes. Thus the concept of costs, manageable rates of change, and other constraints are part of its management, just as much as identifying its benefits.

The advent of the computer has focused managerial attention upon the information system of the corporation. It is here that the computer has had its most direct and greatest impact upon corporate organization.

As management as a profession has developed, increasing weight has been placed on its intellectual aspects--economic theory, the behavioral sciences, and the natural sciences.

Increasing value has been attached to information as an ingredient of the management process, and particularly of the decision making process.

The major driving force, however, behind the corporate demand for current and future data processing products and services is the "time value of information" to management. These "time value" concepts are illustrated below in Figure 3.

Business Trends	Impact on Information			
	More	Better	Faster	Less Costly
Inflation				o
Shortages		o	o	o
Government Impact	o	o		
Geographic Expansion		o	o	
Competition	o	o	o	
Management Sophistication	o	o	o	o
International Markets	o	o	o	

Figure 3. Forces Affecting the Value of Information

The data collected and stored within an organization can be considered to be an inventory of inputs for decision making and/or status reporting. Like any inventory, these items lose value with time. In fact, operational data is a highly perishable quantity relative to its value for decision making.

The chief executive of Gould, Inc., in a recent article in [Business Week, August 23, 1976] describing a real time interactive management information system, has said that

> .....the two most important factors in business are time and cost. Timely information is the biggest asset a manager can have. You can't ask other managers for everything. This way you can do it yourself.

Not all data in this inventory is of the same value. For example, a possible ranking method for each type of data might be assigned:

- Class A data - time critical, used for operational and tactical decision making.
- Class B data - status information, used for communicating the state of the organization.
- Class C data - archival data, stored to meet contingency or historical reporting requirements.

More Class A data is continuously being collected, stored, and made available for faster decision making. While general purpose computers worked well for Class B and C data processing needs, the round-trip pipeline to a corporate computer center for Class A data is too long relative to the time value of that data. Class A data is of increasing importance in maintaining control.

Before discussing the current trends in information systems, it would be helpful to examine the information needs of lower, middle and top management. Generally, lower management is concerned with operational information, while tactical information and strategic information are useful to middle and top management, respectively. The type of information supplied also has to do with activities with which the information is concerned--the internal environment of the organization and the external environment in which the firm

operates. It is a generally recognized fact that internal information should be more and more summarized as the level of management for which it is prepared rises in the hierarchical structure, with top management receiving overall reports of operations for future planning. On the other hand, lower echelons of management, being control oriented, receive the most detailed reports. Between top and lower management is middle management, which is planning-control oriented. Information concerning the external environment of the organization should be summarized in exactly the opposite manner from that of the internal environment. Because the upper managers are more planning oriented and because planning necessitates more information about the organization's external environment, this type of information should be most fully supplied to top management. It should be increasingly summarized and selective as the position of the receiver decreases in the managerial hierarchy.

Operational information, being at the lowest level, is concerned with structured and repetitive activities that are measurable in terms of specific results. It allows line managers, such as plant foremen and department heads, to measure performance against predetermined goals, including standards and budgeted figures. Similarly, operational information allows lower management to comment on how operating standards and policies can be improved to assist day-to-day operations. The feedback of essential information from this low level keeps higher levels of management aware of unfavorable as

well as favorable results. Figure 4 shows the operational information needed to control the major subsystems of a typical firm.

Tactical information that covers relatively short time periods (not greater than twelve months) is used by middle management to implement the highest level strategic plans at the functional levels. As with operational information, tactical information is used by a large number of people. Examples are a functional budget report that compares actual to estimated amounts, a production report that evaluates assembly operations, and a vendor performance report that evaluates overall vendor performance. Typical tactical information generated in a firm is shown in Figure 5.

Strategic information is used primarily by top management and its staff to cover a long time span--generally one to five years. This type of information is employed for planning purposes and for analysis of problem areas to discover underlying reasons for specific problems or conditions. In many cases, the objective of strategic information is to find answers to the question <u>why</u> rather than <u>what</u> or <u>where</u>. Examples of corporate strategic information are shown in Figure 6. Planning must occur before strategic information can be gathered. Strategic planning concerns itself with establishing objectives and policies that will govern the acquisition, use and disposition of the resources needed to achieve these objectives.

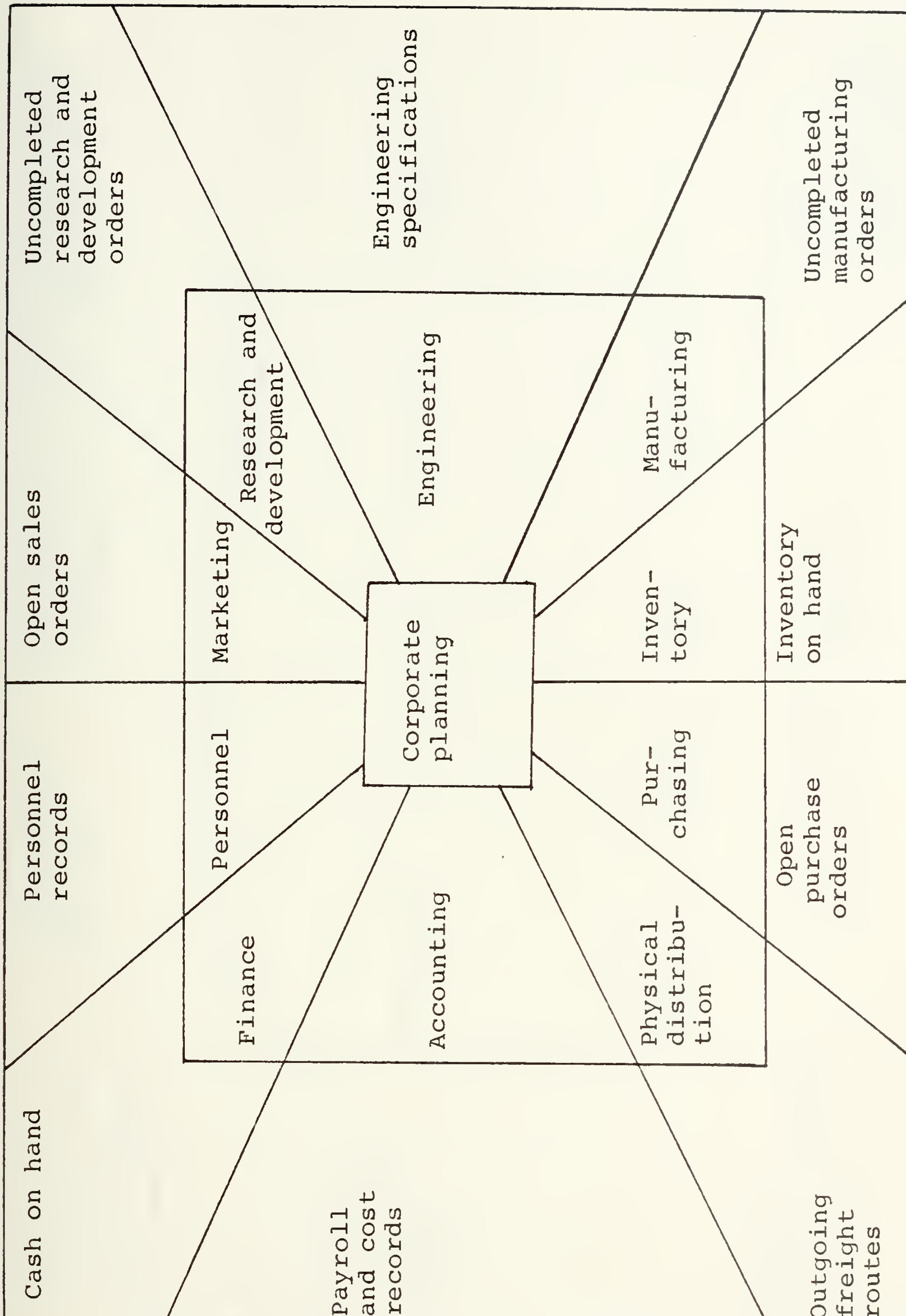

Figure 4. Operational information needed to control the major subsystems of a typical firm.[1]

[1] Source: Thierauf, R., Systems Analysis and Design of Real-time Management Information Systems, Prentice-Hall, Inc., Englewood Cliffs, 1975, p. 45.

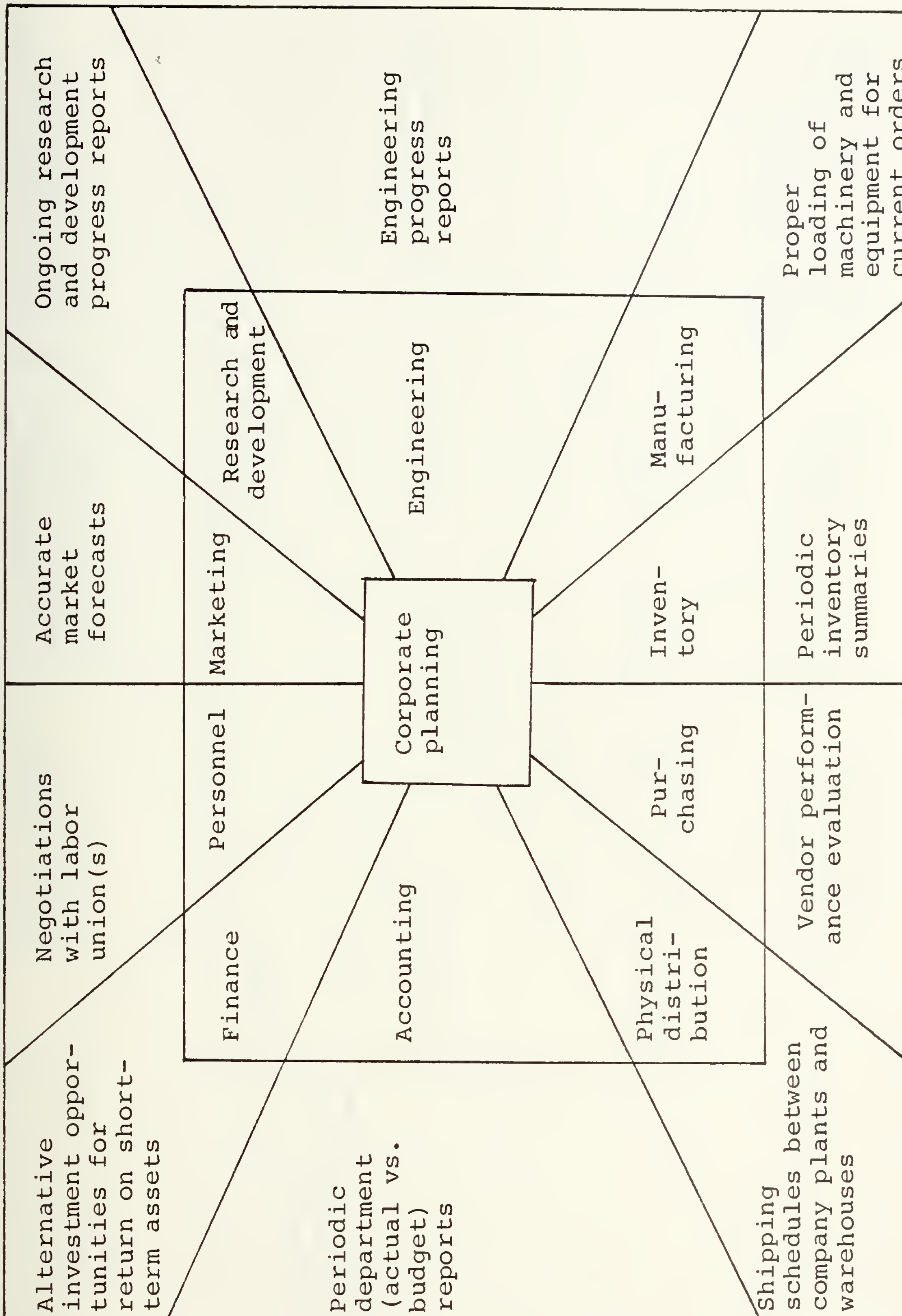

Figure 5. Tactical information needed to implement strategic plans for the major subsystems of a typical firm.[1]

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[1]Source: Thierauf, R., Systems Analysis and Design of Real-time Management Information Systems, Prentice-Hall, Inc., Englewood Cliffs, 1975, p. 46.

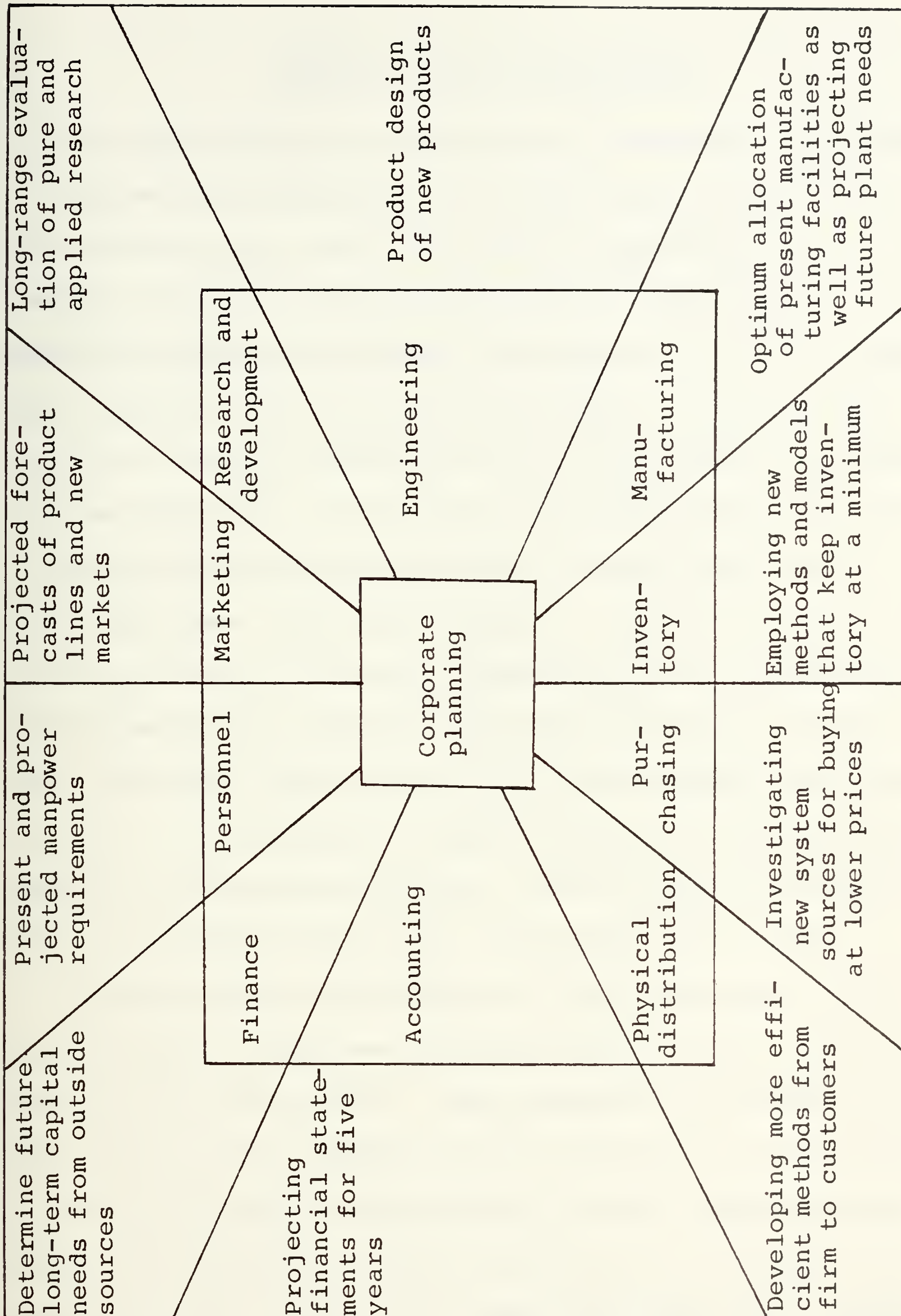

Figure 6. Strategic information needed to plan, organize, direct, and control the major subsystems of a typical firm.[1]

[1]Source: Thierauf, R., Systems Analysis and Design of Real-time Management Information Systems, Prentice-Hall, Inc., Englewood Cliffs, 1975, p. 47.

V. IMPACT ON THE ORGANIZATION

A. THE ORGANIZATION AND INFORMATION TECHNOLOGY - AN ANALOGY

Information technology has within itself almost all of the characteristics that are found in organizations. It has a memory, and, like an individual or an organization, it can exploit its memory and change and improve it. It has communication channels that it uses selectively. It has a wide variety of special problem-solving and information-transforming routines and rules. It can often be connected to some sort of machine that performs mechanical manipulative tasks. It can do all these tasks very rapidly. The only thing it seems clearly to lack is a sensory apparatus of any consequence. Whereas people can "read" an enormous variety of signals or cues coming from the organizational environment, the technology can't. It requires a "layer" of people to perform this reading of information function, and they must translate it into a standardized form that the computer can handle.

The weaknesses and strengths of the technology as an organizational substitute provide a hint of its potential impact on an organization. The incomparable advantage of the human being at the boundary--at the interface of the organization with the physical and cultural world--indicates that people and activities at this organizational boundary are relatively less affected than those performing the "internal" functions of memory maintenance, problem solving, and information transmission and transformation. The problem of

understanding the effects of computers on organizations is, in large part, one of sorting out traditional human activities in the organization in the terms just described and estimating the rate of substitution of technology for man in their performance.

Information technology at work stores, transmits, and transforms information, and, in addition, applies it to the solution of problems. This is exactly what a great number of people in the modern organization have traditionally done. If the technology is substituted in part for man because it has a comparative economic advantage, what is the source of this advantage?

The advantage seems to lie in the great capacity, the high speed, and the reliability of the machines as compared with men. To translate this into organizational effects, one must understand how organizations have traditionally coped with the relatively low capacity, low speed, and low reliability of men in performing organizational tasks. The limited capacity of the individual has been dealt with by the process of specialization, with one group mastering certain skills and applying them while other groups have different responsibilities.

Specialization also helps solve the problem of speed or, stated differently, the problem of getting a lot of work done in a hurry. By breaking the over-all tasks into parts and allowing people to perform these parts simultaneously, the length of time necessary to get the organizational job

done is tremendously shortened. The price paid for this shortening of time is, of course, the assumption of a problem of coordination. Man's propensity for error and malperformance gives rise to elaborate and cumbersome systems of control. Hence, the shape of the modern organization has been derived--one in which hierarchical levels of coordination and control are built in, in an effort to get a wide variety of individuals in specialized tasks to do what they are supposed to do when they are supposed to do it.

[Grindley and Humble, 1973] discuss the impact of the computer on the control aspects of two different industrial applications.

> One effect of computer data processing has been to highlight the difference between two forms of control: human control and mechanized control. We may expect the computer to influence future organization structure so that it reflects this distinction. For example, in each function there may be one manager concerned with discretionary control and another responsible for its formal or reflex control systems. The alternative to this is to give the responsibility for the reflex control area within each function to the computer department. Many companies adopt an uneasy compromise in this respect:
>
>> A bank, having computerized its accounts, nominally left all the responsibility for their maintenance with the branch managers. The branch managers were not, in fact, responsible for account accuracy, for making regular payments as instructed by customers, or for the provision of statements. While they became much more effective regarding the discretionary aspect of their work (selling the bank's services, etc.), they lost much of their authority concerning routine control to the computer center manager.
>
> Occasionally, however, we find organization structures which recognize the two separate forms of control but retain responsibility for both within the line function concerned.

A chain of retail stores automated part of its buying procedures. This mechanization of routine buying allowed buyers to concentrate on getting the best prices, i.e., on discretionary control. However, the purchasing manager appointed two managers under him, a chief buyer responsible for negotiating contracts and a buying systems manager responsible for developing the rules covering routine work.

B. CONFLICT AND ITS EFFECTS

1. The Nature of Conflict

The information systems department (ISD) has the potential for achieving a condition of conflict in the modern organization, although the following discussion is not intended to imply that any one ISD meets all of the conflict conditions. These conditions for conflict might include:

- Mutual task dependence
- Asymmetrical work relationships
- Different performance criteria and rewards
- Differentiation
- Role dissatisfaction
- Ambiguities
- Dependence on common resources
- Personal skills and traits
- Communication obstacles

The ISD increasingly controls strategic contingencies for other departments; other departments depend on the ISD. That department also depends on the users for input, error correction, and assistance in designing systems. The relationship between users and the ISD is asymmetric because the ISD staff often feels it must understand users' jobs, whereas the reverse is not always true. Performance criteria and rewards also differ between the two groups. The ISD is a highly differentiated specialty; unlike more conventional organization

structures, small task forces are used to design systems. There are also many communications obstacles between the computer specialists and users. Technical jargon can easily confuse users. Another communication problem occurs during system design when the computer specialists attempt to learn user problems. Communication problems may prevent the ISD staff from understanding how the user works with information and, what his needs are for a system solution.

In order to provide the reader with a better understanding of the underlying behavioral reasons for possible conflict, the following paragraph presents some fundamental characteristics of the participants, namely, the computer specialists (ISD staff) and managers (users).

2. The Participants

A great deal has been written in recent years about the continuing tensions and antagonisms arising from the different backgrounds and expectations of managers and computer specialists. This difference has been described by [Rose, 1969] (drawing on a distinction originally made by A. W. Gouldner) in terms of "cosmopolitans," e.g., computer men who look outside the organization for their career and their standards of judgement, and managers, "locals," who usually identify with the single organization in which they have spent most if not all of their working lives.

A profile of the computer specialist provides us with insight into some of the potential conditions and states of mind that could produce conflict. The "average computer

specialist" is likely to be in his thirties. If he is younger, he will probably have been in the computer/management science field since he entered business. In formal education terms he will usually be better qualified than "Mr. Average Manager." His biggest satisfaction comes from the challenge of analyzing and solving problems--and he is extremely conscious of the potential of the computer, its excitement, its novelty. He gets strong motivation from his work, but, unless positively involved in the corporation's problems, may drift into applying his considerable abilities to purely technical problems. The best people are scarce, expensive, and mobile--and they know it. They belong to what has been termed the 'invisible university' of the computer fraternity. [Weizenbaum, 1976] has described the innate power of a computer specialist (programmer);

> The computer programmer, however, is a creator of universes for which he alone is the lawgiver. So, of course, is the designer of any game. But universes of virtually unlimited complexity can be created in the form of computer programs. Moreover, and this is a crucial point, systems so formulated and elaborated act out their programmed scripts. They compliantly obey their laws and vividly exhibit their obedient behavior. No playwright, no stage director, no emperor, however powerful, has ever exercised such absolute authority to arrange a stage or a field of battle and to command such unswervingly dutiful actors or troops.

[Weizenbaum, 1976] also describes two classes of programmers, the professional and the compulsive, and provides an understanding and formula for identifying and coping with these two phenomena in the remainder of the chapter entitled "Science and the Compulsive Programmer."

How may the compulsive programmer be distinguished from a merely dedicated, hard-working professional programmer? First, by the fact that the ordinary professional programmer addresses himself to the problem to be solved, whereas the compulsive sees the problem mainly as an opportunity to interact with the computer. The ordinary computer programmer will usually discuss both his substantive and his technical programming problem with others. He will generally do lengthy preparatory work, such as writing and flow diagramming, before beginning work with the computer itself. The professional regards programming as a means toward an end, not as an end in itself. His satisfaction comes from having solved a substantive problem, not from having bent a computer to his will.

The compulsive programmer is usually a superb technician, moreover, one who knows every detail of the computer he works on, its peripheral equipment, the computer's operating system, etc. He is often tolerated around computer centers because of his knowledge of the system and because he can write small subsystem programs quickly, that is, in one or two sessions of, say, twenty hours each.

Usually the systems he undertakes to build, and on which he works feverishly, for perhaps a month or two or three, have very grandiose but extremely imprecisely stated goals. Some examples of these ambitions are: new computer languages to facilitate man-machine communication; a general system that can be taught to play any board game; a system to make it easier for computer experts to write super-systems (this last is a favorite). It is characteristic of many such projects that the programmer can long continue in the conviction that they demand knowledge about nothing but computers, programming, etc. And that knowledge he, of course, commands in abundance. Indeed, the point at which such work is often abandoned is precisely when it ceases to be purely incestuous, i.e., when programming would have to be interrupted in order that knowledge from outside the computer world may be acquired.

[Weizenbaum, 1976] then provides a glimpse of the power, both intrinsic and potential, that computers wield:

Science and technology are sustained by their translations into power and control. To the extent that computers and computation may be counted as part of science and technology, they feed at the same table. The extreme phenomenon of the compulsive programmer teaches us that computers have the power to sustain megalomaniac fantasies. But that power of the computer

is merely an extreme version of a power that is inherent in all self-validating systems of thought.

The manager, as an arbiter and user of information services, is the other link in the conflict process. It is appropriate to briefly discuss the managerial dilemma with regards to data processing.

The age range of most modern top executives in government and business--in their early or late fifties-- is a contributing factor to the problem of perceptions and attitudes. They have been trained and attained success in their careers without experiencing the need or opportunity to become familiar with the intimate working details of modern information technology. And, confronted by the spectra of data processing in their own operation and decisions regarding its acquisition and use, they are often persuaded by glib salesmen or over enthusiastic technicians (computer specialists) to make decisions that are not in their organization's best interests.

The executive, this manager of management, has gained respect for his performance as the leader of his organization, has professional stature in his own field, and is usually unwilling--at least reluctant--to reveal his ignorance of the exotic world of data processing. In defense, he may have totally withdrawn from the scene, trusting that the experts he hires will work their magic to produce a successful data processing operation. He may have relegated the computer and its concomitants to the status of operational backups; like

the elevator and the air conditioner, they will function and serve the organization because people are charged with making them run.

The "Average Manager" has been described by [Mant, 1971] in the following way:

> He tends to be in his late forties--past the first blush of ambition but not yet on the run home. He does not attract memorable labels ("crown prince," etc.) because his visibility within and without the company is low. ... He is responsible and willing and has probably made a rational accommodation to limited prospects in the company. He provides the continuity and stability in the infrastructure of the organization, leaving the most spectacular performance and promotion to the others. He is basically conservative but still capable of change. ... Unless he is in line for immediate promotion, he is likely to use new ideas and techniques only so far as he can immediately apply them.

It should be noted, however, that conflict between these groups of diverse people is not necessarily harmful. In conditions of uncertainty, when new information systems are being presented for consideration or testing, conflict may be a way of selection between the views of the innovators and those of the more conservative managers. Conflict in times of change may be beneficial but has to be kept within reasonable limits. [Stewart, 1971] suggests in her study of a large group of users that one of the strengths of the British Petroleum Company (BP) was the tolerance that continued among the participants despite sharp disagreements about policies and methods.

C. POWER AND POLITICS

1. Subunit Analysis

Recently a theory of organizational power has been developed which focuses on subunits of the organization as the unit of analysis rather than on individuals [Hickson and others, 1971]. The model relates the amount of power held by a subunit to four variables: uncertainty, substitutability, work flow centrality and immediacy, and the control of strategic contingencies. According to the model, the more a subunit copes with uncertainty, the more power it will have. For routine information systems the user depends on the operations group of the information services department (ISD) to produce output accurately and on schedule. The output of the ISD controls some of the uncertainty the user experiences in his work. The department also produces information which can be used to reduce a decisionmaker's uncertainty. During systems design, the ISD designs a new system which assumes some of the functions the user controlled in the past. Here, the ISD has created uncertainty for the user which only the ISD can resolve.

The power model also indicates that, the greater the indispensability of a subunit, the greater is its power. There are few alternatives to the ISD, particularly if the department already exists and the organization has its own equipment.

The power model also hypothesizes that, the greater the pervasiveness and the immediacy of the work flows, the

greater is the power of the subunit. If work flows are highly independent among subunits, then a key department will be powerful. Immediacy of work flows refers to the speed with which a problem in one department affects others. Depending on the nature of the application, the ISD may have high work flow pervasiveness and immediacy. For example, interruption of on-line service in a reservation system can drastically affect the functioning of other departments in the organization.

The final variable in the power model is the control of contingencies; the more control of other subunits' strategic contingencies by a subunit, the greater is its power. Control over strategic contingencies relates to the interdependence between subunits; if A controls many of B's contingencies, than B is dependent on A. One of the unique aspects of the ISD is its relationship with a number of different areas and subunits within the organization. For both the operation and the design of information systems, the ISD controls many contingencies for other subunits.

The ISD contains an inherently high level of relevance on all of the power model variables, though the concentration of power in this subunit is often unrecognized. When information systems are implemented, there has been a tendency to focus on each individual application and not see the entire impact of all systems on the organization. The information services staff and users have ignored the gradual transfer of power to the ISD and the problems this may

create. Users have become more powerless and more frustrated without understanding the reasons or even recognizing that the problem exists.

[Lucas, 1975] provides an image of the attitudes of users toward the ISD as a result of his study on the power perception of the users:

> The frustration and uneasiness are reflected in unfavorable attitudes toward information systems and the information systems staff. Unfavorable attitudes influence user cooperation with and use of information systems.

2. Resistance to Information Sharing

Information-sharing includes sharing organizational information about: data, data sources, and data collection methods; program instructions for processing, combining, disaggregating, and summarizing the data; interpretations of the data and the theories or assumptions upon which interpretations are made; and decisions about who has access to any of the above, including who is obligated to use what data, programs, or interpretive concepts as a basis for organizational action.

Today a person's or a subunit's power in an organization is often a function of the capability to preempt information. By controlling access to information, persons or subunits can protect themselves somewhat from invasions of authority because others lack the information they would need or could use to dislodge them. They can define their situations much more as they choose to because they have information about it that others lack. Indeed, others may also judge

their significance through their image of reality because others have less information about the environment--except possibly the people who comprise it. They can bargain with information for power and status and for other information they need to improve their control capability and status. [Downs, 1967] suggests some of the current problems of organizational politics for information-sharing systems such as urban data banks and management information systems (MIS):

> Within city governments, those who actually control automatic data systems gain in power at the expense of those who do not. Most city officials are acutely aware of this potential power shift. Each operating department naturally wants to retain as much power as possible over its own behavior and its traditional sphere of activity. Its members are especially anxious to prevent "outsiders" from having detailed knowledge about every aspect of the department's operations. Hence, nearly every department with operations susceptible to computerized management will at least initially fight for its own computer and data system controlled by its own members.

[Argyris, 1970] discusses the operational politics that a Management Information System (MIS) can engender:

> The manager's reactions to threats and arrogance (from MIS-connected personnel) can be predicted. His feelings of mistrust, suspicion, and fears of inadequacy find ways to influence other managers to let the MIS group atrophy or be disbanded. For example, not enough company departments will be persuaded to pay for the MIS services. Or management will find that people don't understand the value of the new systems.

3. Structural Aspects

The organization's structural sources that encourage resistance to information-sharing have been very well described by [Wilensky, 1967] to be the results of hierarchy, specialization, and centralization.

a. Hierarchy

The issue of hierarchy is discussed by [Wilensky, 1967] in the following terms;

> Information is a resource that symbolizes status, enhances authority, and shapes careers. In reporting at every level, hierarchy is conducive to concealment and misrepresentation. Subordinates are asked to transmit information that can be used to evaluate their performance. Their motive for "making it look good," for "playing it safe," is obvious. A study [Read, 1959] of 52 middle managers (mean age 37) found a high correlation between upward work-life mobility and holding back "problem" information about such issues as lack of authority to meet responsibilities, fights with other units, unforeseen costs, rapid changes in production scheduling or work flow, fruitless progress reports, constant interruptions, insufficient time or budget to train subordinates, insufficient equipment or supplies, and so on. Restriction of such problem information is motivated by the desire not only to please but also to preserve comfortable routines of work: if the subordinate alerts the boss to pending trouble, the former is apt to find himself on a committee to solve the problem. Hierarchy blocks communication, blockages lead to indoctrination; indoctrination narrows the range of communication.

b. Specialization

Specialization is a source of resistance from those individuals who are rewarded by the organization for the norms that are designed around particular functions or competences. There are two major aspects of this subject area that are explored by both Wilensky and Argyris, namely power maintenance and risk taking. The first aspect, the maintenance of power, is discussed by [Wilensky, 1967]:

> As a source of information blockage and distortion, specialization may be more powerful than hierarchy. Each service, each division, indeed every subunit, becomes a guardian of its own mission, standards, and skills; lines of organization become lines of loyalty and secrecy. .... Top men are reluctant to let their subordinates "take on" rivals by asking for information for fear that their unit will betray weakness, invite counter-inquiries, or incur debt. While information

> can also be used to persuade potential allies and to facilitate accommodation with rivals.....it is more commonly hoarded for selective use in less collaborative struggles for power and position.

A second source of resistance from specialized subunits will be their reluctance to risk present operation styles and rewards in order to use the new and untested information technology. The underlying reasons for this risk-adverse position of top executives is explored by [Argyris, 1970]:

> There is a deeper reason for executive resistance. It's rarely discussed because executives themselves are rarely aware of it. This basic, unspoken reason usually surfaces after lengthy discussion about the probable long-range effects of MIS. At this point, managers slowly begin to realize that fundamental change will be required in their personal styles of managerial thought and behavior. That's when the danger signals start. Those other stated objections--lack of knowledge and the primitive state of the art--are important, but only temporary. Eventually they will be overcome by research and dissemination of knowledge. But concern and fear about what MIS will do to managers is what creates the basic resistance.

c. Centralization

The third structural contributor to resistance to information sharing is centralization and the relevant dilemma of information control is discussed by [Wilensky, 1967]:

> Related to the information pathologies of hierarchy and specialization is the dilemma of centralization: if intelligence is lodged at the top, too few officials and experts with too little accurate and relevant information are too far out of touch and too over-loaded to function effectively; on the other hand, if intelligence is scattered throughout the organization, many subordinate units, too many officials and experts with too much specialized information may engage in dysfunctional competition, may delay decisions while they warily consult each other, and may distort information as they

pass it up. More simply, plans are manageable only if we delegate, plans are coordinated in relation to organizational goals only if we centralize.

[Argyris, 1970] describes the effects of centralization on the perceptions of management:

> As the informal modes become explicit, information comes increasingly under the control of top management. The top level starts to see things it never saw before. Middle managers feel increasingly hemmed in. In psychological language, they will experience a great restriction of their space of free movement, resulting in feelings of lack of choice, pressure, psychological failure. These feelings in turn can lead to increasing feelings of helplessness and decreasing feelings of responsibility. Result: a tendency to withdraw or to become dependent upon those who created or approved the restriction of space of free movement. Sound familiar? MIS can do to middle and near-top management exactly what the job specialization does to lower-level employees.

VI. TECHNOLOGY CHANGES AND ORGANIZATIONAL IMPLICATIONS

Many forecasts are available on the future of organizations and management. The hazards of forecasting technology impacts on organizations are represented in the often quoted predictions made by [Leavitt and Whisler, 1958]. Because of the new technology epitomized by the high speed computer and the emergence of operations research methods, the authors projected a drastic change in the roles and functions of middle and upper management. Middle management tasks would become more structured, because a greater portion of the work at that level would be programmed. The line between middle and upper management would become more distinct as certain middle-management jobs moved downward in the hierarchy, and former middle-management tasks relating to planning, innovation, and creativity would rise to become essentially the exclusive domain of top management. In effect, they were projecting a move toward recentralization in organizations.

Even though electronic data processing has influenced organization structure and the tasks of managers, it has not resulted in the withering away of middle-management positions and a major return to centralization [Stewart, 1971]. On the contrary, within ten years [Bennis, 1966] was predicting that

> Adaptive, temporary systems of diverse specialists. .... linked together by coordinating and task-evaluative specialists in organic flux will gradually replace bureaucracy as we know it.

More specifically, in 1973 another noted analyst made the following projection [Mee, 1973]:

> The manager of the future will deal with highly complex organizations. The organizational vehicle will not be the hierarchical pyramid in which decisions are centralized and most of the planning is done at the top.

Data processing power is currently available in equipment in addition to minicomputer systems, terminals, or other products normally under the jurisdictional control of data processing management. This equipment includes:

- text processors
- personal computers (IBM 5100, WANG 1100, etc.)
- digital numerical control processors
- electronic PBX
- processor based replicating and duplicating equipment (such as the XEROX 9200)
- digital facsimile transmitter
- facilities monitoring systems

All of this equipment--again generally not under the control of data processing management--has substantial spare processing capability which could conceivably be tapped to satisfy information needs in a more timely fashion.

New products will provide for the evolution of a hierarchy of information handling vehicles, which are optimized to specific tasks and have capabilities of processing and storing data at many levels. There is a growing and dominant realization in the literature on this topic that a computer-oriented application is not a monolithic task, but many tightly or loosely coupled interrelating functions. [Pullen and Simko, 1977] have recently presented their views on the impact of distributive processing on the user of data processing services:

Distributive processing is moving computer power and data storage capabilities physically closer to the ultimate user, at the task level. Examples are found in POS (Point of Sale), factory data collection, text processing, inventory control, order entry, production line scheduling, process control, data entry, and general purpose transaction processing. As critical parts are stored closer to the production lines, so will critical data be stored closer to the decision-making points. In essence, it is data distribution that is creating the demand for the distribution of data processing power such that the time value of information can be maximized.

[Pullen and Simko, 1977] also cite two effects on companies that will occur as a result of distributive processing:

Distribution of data processing capabilities will have two basic impacts on a company. First, there will be staff reductions in clerical and support personnel as a result of transaction automation (users will directly interact with the system); second, there will be an increase in requirements for data processing professionals. Direct data entry, per se, will be the responsibility of the operating units. Transaction processing loops will be significantly shortened by the use of micro processors and low cost/volume storage capabilities at the point of data entry.

[Kanter, 1973] describes the emerging role of the information systems executive and the alternative course of action"

Tomorrow's EDP manager will find himself with a widened sphere of responsibility and a more strategic location within his company's organization. More and more companies are placing their total information processing requirement under a top computer executive (TCE) who reports to a senior vice president or directly to the president, and, in many instances, himself is a vice president.

Only those companies which continue to operate with the EDP perspective of the fifties and sixties will place the EDP functions under the direction of the accounting department. The more enlightened companies, which view information and its processing as an asset, as a source of power equal to, or greater than, the traditional three m's--men, machines, and money--will adopt the TCE concept.

As a socializing force, the new computer technology can help managers to think and act with better understanding of the framework of the corporate organization, not just their own department. The department syndrome, the consideration and promotion of limited departmental objectives which may vary from corporate interests, is a serious problem in corporate performance today because of overall corporate size and complexity. Educational and value differences and conflicts among specialists within departments aggravate this problem. [Fahey, 1969] provides an example of the use of the computer as a device to resolve these departmental conflicts:

> The scientist or engineer engaged in product development often has difficulty communicating with sales or marketing personnel and seeing their needs. The fundamental need for each to understand the other and for both to understand the broader corporation is so great that it is almost constructive to increase their understanding of the economic and technical realities facing both departments. Mutual confrontation of the whole cycle of product development according to revenue, cost, and time "models" reflecting the state and direction of the corporation's broader activities can provide a basis for more meaningful communication among managers of complementary departments engaged in the same corporate process, be it production or new product development and introduction. Computer models can help to refine corporate goals and strategies, and, in turn, corporate objectives, divisional and departmental tasks and standards, placing them in a context which is entirely practical for day-to-day decision making.

A fourth generation of hardware and software to support data base-oriented processing is currently in its adolescence [Stein, 1977], and by the late 1970's all major computer manufacturers will be delivering mature fourth-generation products. The dominant configuration will use inexpensive

satellite computers to perform local functions and to communicate with the central system where the data base resides. The central system will employ highly cost-effective disk storage, mature data-base management software, and software/hardware techniques that enable a machine to adjust itself for optimum performance of different kinds of work running concurrently--a method referred to as virtual machine techniques [Turn, 1974].

The experience of pioneering fourth-generation users such as Weyerhauser, Zayre, and the Department of Defense indicates that this generation will cause substantial redistributions of management functions in the organization [Withington, 1974]. Most notably, procurement, transportation, personnel administration, cash management, and other logistic functions will be moved from the field to headquarters to achieve economies of scale available from applying specialist skills to the pooled needs of the entire organization. These logistic functions had formerly been decentralized only because it was impractical to bring all the detailed data together; field managers have never welcomed these administrative responsibilities and may well be glad to be relieved of them.

Tactical decision making, by contrast, is moving from headquarters out to the field. In the past, imperfect data required that time-pressured decisions be made intuitively using the most trustworthy experience available, and this experience has usually been found at headquarters. Now the information specialists can provide anyone, anywhere with all

the relevant data and records, plus supporting services such as exact pricing calculations. This trend is slowly reducing managerial reliance on subjective judgement based on experience and is increasing managerial reliance on on-the-spot knowledge of the situation; as a consequence, the field manager's authority is gradually being increased.

[Withington, 1974] describes a situation in the banking industry that illustrates the impact of distributed processing on the central office managers as a result of increased authority given to the branch manager:

> In one bank, the size of the maximum loan a bank manager is authorized to approve has been quadrupled because he has direct access to a central computer-based customer credit file. As a result of the decreased number of forwarded loan applications, the number of loan officers at the central office has been cut in half.

[Pullen and Simko, 1977] have presented an image of the corporate information systems scheme for the 1980's. The authors suggest that:

> An emerging information management configuration will be complex and highly integrated with all corporate functions. To deal with this environment, companies will need to develop some very different concepts and skills. Data processing management will be joined, or eclipsed by: a corporate communications architect/administrator, an information inventory/resource manager, and a corporate teleprocessing/communications manager.

If the potential benefits of data processing are to be realized, the most important changes required over the next decade will be those of management's approach to data processing. As enterprises begin to understand the value of their corporate data as assets, many questions will arise regarding custody of, and access to, these assets. It is

doubtful that questions regarding access to data can be resolved by the data processing departments alone; other elements of management associated with the data itself will be involved. For data processing to provide benefits to end users, it needs to be viewed as an integral part of the enterprise, receiving direct management support from other organizational entities, and responding to changes in the enterprise and in the emphasis on the business.

VII. CONCLUSIONS

It should be clear from the material presented, that it is virtually impossible to develop and utilize information systems in isolation, since many groups in the organization are involved. Even for systems supporting a single decision-maker, computer personnel from a subunit other than the user's, must work with him. Thus, new interpersonal relationships are established as information systems are developed. For some of the new applications a number of functional areas in the organization will use a single system, requiring more coordination among these areas. Such systems introduce new dependencies among the subunits and between the information services department and the subunits. A major new department (ISD) which is responsible for information systems has developed, and the increasing power of this new subunit has an impact on the structure of the organization. New dependencies and power relationships among departments as a result of the development of an information system can create major organizational behavior problems.

A data processing installation used to be operationally defined as a room full of computers and key punches surrounded by mid and end users. The advent of third generation systems (Withington's Stage III) added large numbers of system support people. In the future, some of these rooms full of computers (as well as a sizable fraction of both the key punches and the support staff) can and will be replaced by remote job

entry stations and by end user terminals. Alternatively, such "computerless" work stations may be placed with groups that have never before had any kind of computer installation.

Such computerless installations might well be controlled organizationally by their users rather than by the data processing centers. This, in turn, might have a significant impact on the management style and career-path potential of those concerned with the operation and use of such installations. While the data processing industry has learned a little about how to evaluate the operations function of a "classical" data processing center, it has tended to ignore, in this process, the end users and applications developers surrounding such a center. Work is needed <u>now</u> to establish management criteria and procedures for appraising the computerless installation and for obtaining an overall evaluation of an installation that happens to also contain "classical" data processing operations.

The method discussed in Section III.B. defining the stages of growth of any organization requires that one should consider the organization's total information expenses, including clerical and administrative labor, as the base against which progress should be measured. The big divide is then that portion of the total information processing expense that is subject to systematized control, measurement, and management. For typical organizations there exists a coexistence of several technologies and of several investment opportunities simultaneously at various stages of development, where

data processing may be at Stage IV, telecommunications at Stage II, word processing at Stage II, and general administrative systems just beginning to emerge. Opportunities for improved cost/benefit performance exist in these new application areas because of their latent potential originating from the fact that they have been largely neglected in the past 10 to 20 years when most energies were diverted to the glamour of data processing. As increased understanding takes place concerning these opportunities, project development resources will be shifted where the potential return to the organization is maximized. As was discussed in Section IV.B., not all data in the corporate inventory is of the same value. This fact is forcing data processing management to accept distributed processing systems, and will require executive management to invest heavily in even more sophisticated information systems.

The changes in the organization will put some new demands on data processing professionals. Data processing management desires control of data processing and communication facilities relative to their selection, operation, integration, and prioritization. Executive management desires control of data flow relative to enforcement of corporate policies, measurement of corporate and management performance, and maximizing corporate benefits while minimizing costs. These are not necessarily conflicting nor irreconcilable benefits, but they will require serious redirection of managers' training and attitudes. The latter will require

a different set of management skills (less technical and supervisory, more conceptual and coordinated) to optimize the information processing function in the firm. The profile of data processing professionals will be changing to stress the following:

- o user training/orientation skills
- o systems analysis experience and capabilities
- o industrial engineering background or training
- o minicomputer programming experience
- o telecommunications networking experience.

The changing role relationships between the data processing professional and the users of data processing services in the future use of distributive computing networks will result in the data processing professionals spending more time in the field at user sites. With the blending of information functions into the basic fabric of the business operation, the essential job requirements of the data processing professional will require an awareness and appreciation of management's overall information needs and a practical systems perspective built on the business facts of life. The data processing manager who builds his career solely on his technical expertise, if he is lucky, finds himself in a technical staff capacity while someone far less technical, but a lot more in tune with business operations, runs the show.

The trends in data processing applications indicate that, in all segments of the corporate area where data processing applications originate today, such applications will grow into large, integrated sets of applications systems oriented

toward on-line transaction processing, with heavy data-base and data communications requirements. At the same time, the accelerating proliferation of stand-alone minicomputer-based systems will continue, with such systems serving as "intelligent" terminals in hierarchical computer networks and as increasingly practical and appealing devices for implementing "isolated" applications requiring only locally available data. The rate at which communications-based data processing will grow (including networks of computers) is dependent upon the bigger issue of the distribution of data processing power (centralized versus decentralized data processing). This last issue presents some very complex problems with managerial, administrative, and "political" overtones, and, in addition, has a number of genuinely technological problems associated with it. The growth of data-base applications will push toward centralization until and unless the problems of distributed data bases and computer networks are solved in a commercially viable fashion. Therefore, data processing management, and indeed, general management, faces a severe test. Present management techniques cannot cope either with the increasingly complex technological environment, nor with the growing user dependence on and expectations from data processing services.

VIII. RECOMMENDATIONS

Section V presented a brief discussion of some of the behavioral reasons that are behind the lack of success of some information systems. First, many parties, including management, users, and the information services department staff (data processing professionals) are involved in the design and operation of information systems. All of these groups must work together to develop and operate successful systems. Second, a number of variables are involved in the design and operation of successful systems. The complex relationships among technical, behavioral, situational, and personal factors all must be considered. If any variable is ignored, systems are likely to fail. The goal of this section is to provide some ideas for consideration in order to develop successful information systems which have a high level of use and make a positive contribution to decision-makers and the organization.

A. OPERATIONS

The operation of existing information systems is an important activity. The information services department (ISD) provides a service, and users form attitudes from their contact with operations; it should be easy and enjoyable for the user to use the systems. The following guidelines for operations based primarily on the importance of service quality are presented:

1. Develop user representatives for applications to interface the user with the ISD. For any given system, no matter what the problem, the user should be able to contact a single representative of the ISD who is responsible for seeing that the problem is solved.
2. Plan for changes to existing systems as users gain experience with them, and allocate a portion of the budget for changes. Try to originate changes; for example, monitor users' reactions to determine what modifications are needed.
3. Consider the use of a steering committee to set priorities for the operation of systems.
4. Provide sufficient computer capacity to meet special requests and peak processing loads. The ability to respond quickly to special jobs is one highly visible sign of responsiveness and high quality service.
5. Be certain that existing systems are operating at a satisfactory level of performance as evaluated by users before beginning the development of new systems.

B. SYSTEMS DESIGN

Systems design is crucial to the organization and to the development of successful information systems. The control and processing of information is vitally important to the organization's success and survival. The systems design

process is a creative activity which involves a number of individuals from different areas in the organization. Several important design considerations are presented below with the intent of coping with some of the behavioral issues raised in Sections IV, V, and VI.

1. Let the user design the system if possible. The information services staff should act as a catalyst and map the user's functional and logical design into manual procedures and computer programs.
2. Consider the use of a steering committee of users and the ISD staff to allocate resources and make decisions on proposed applications.
3. Consider and diagnose the multiple roles of information for different decisionmakers and decision-making situations. For example, a distinction has been made in Section IV.B. between tactical and status information. Exception reporting might be appropriate for tactical problems. For status information, users might respond favorably if able to obtain data as needed, possibly through batch retrieval packages or an on-line inquiry facility.
4. Consider different personal and situational factors and decision styles in developing systems. Provide enough flexibility that users in different environments and with different levels of experience, education, etc., can benefit from the system.

5. Develop a good user interface; for example, consider the use of on-line systems to reduce the burden of input and output on users. Make it easy mechanically to use the system.
6. Include training in the design of the system, possibly by having the user design team train others so that high levels of use of a system will be possible.

C. ORGANIZATIONAL

The guidelines and recommendations above have been suggested to improve the operation and design of information systems. However, these steps are not sufficient to prevent information systems from becoming failures. The spirit of the recommendations is of major importance; a set of attitudes and an approach to information system activities which consciously considers the context of the organization underlie the recommendations. The three major groups in the organization concerned with information systems (management, users, and the information services department staff) must adopt this perspective and cooperate to see that the recommendations like those above are followed.

Management has the responsibility to set goals and priorities for the ISD and users. What types of systems should be stressed, and are the systems under development consistent with the overall goals and objectives of the organization? Management also has the responsibility to influence users and the ISD by participating in decisions about information

systems, including decisions on the selection of new applications and on systems design issues. Finally, management influences users and the ISD. Users should be rewarded for their cooperation and participation in design. The ISD staff should be rewarded for the design of successful, user-oriented systems, not just for implementing a system.

Users have the responsibility to learn about information systems, contribute to their operation and development, and participate in making intelligent decisions about them. Users need to participate in systems design and, wherever possible, should design systems themselves. User input is necessary in order to develop a high quality system; participation in design makes implementation easier and stimulates greater use of the system. To encourage use of systems, users could form groups for different systems; the groups meeting and trading ideas on how best to use the output of the system.

The information systems department has much of the responsibility for designing and operating successful information systems. The recommendations made in the two paragraphs of this section are basically aimed at the ISD. The emphasis on the development of systems must be on the quality of service as perceived by the users. The individual differences among users in situational, personal, and decision style variables should be understood and accepted by the staff. The various roles of information and the importance of favorable user attitudes should also be stressed. For

the ISD the basis of the recommended approach is a philosophy of user-oriented design and operations. Quality rather than quantity is emphasized. If this approach is followed, systems will probably take longer to develop and will cost more. However, if the analysis is correct, such information systems should be more heavily used and should make a greater contribution to the decisionmaker and the organization than do existing systems.

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